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IR spectra of polystyrene-based composite films

E.V. Barabanova, Ya.V. Vorob'eva, A.M. Ivanov, O.V. Malyshkina

Tver State University, 170100, Tver, Russia
pechenkin_kat@mail.ru

In the work, the transmission spectra of polystyrene-based polymer films with a filler of lead zirconate titanate (PZT) ceramics were studied by IR spectroscopy. The films were produced from a solution of polystyrene in toluene. The ferroelectric ceramics were ground to a particle size of not more than 4 μm. The filler was introduced in volume concentrations of 10, 20, 35, and 50%.

Except transmittance of composite films were investigated pure polystyrene films obtained from a solution in toluene and industrially from the melt (test sample to the spectrometer). As can be seen from fig. 1 the spectrum of a polystyrene film obtained from a solution is less transparent than a reference film obtained from a melt. This can be explained by the scattering of incident radiation on the pores formed during solidification of the film from the solution by evaporation of toluene. Also to the absorption bands of polystyrene in the film obtained from the solution added to the absorption band of toluene. The most intense is the band at 1072 cm^{-1}.

As a result, even a small amount of ceramics in the polymer turns out that the film becomes completely opaque with the exception of a small area in the area of "fingerprints" [1, 2]. The transmission peaks are clearly located between the absorption bands of polystyrene and toluene and correspond to 449, 889, 935, and 1228 cm^{-1}. But their intensity is low and decreases with increasing filler concentration. Consequently, the region of transparency of the PZT is superimposed on the region of the characteristic frequencies of polystyrene. This leads to the transmission of the composite film in a narrow frequency range. However, at high concentrations of filler light is scattered by the pores and grain boundaries. This makes the composite completely opaque.

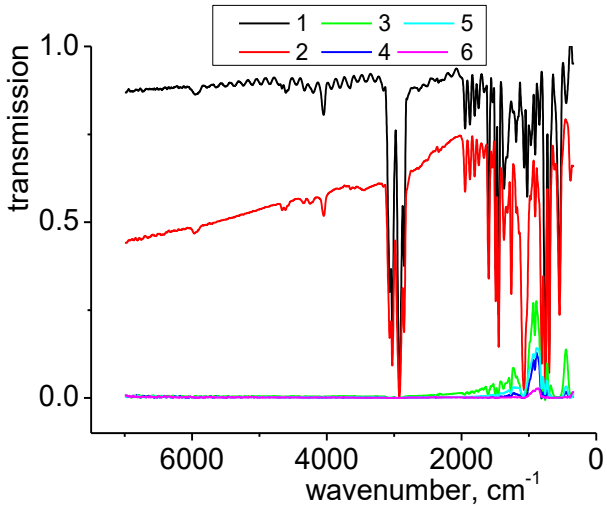

Figure 1. Transmission spectra for a films of pure polystyrene obtained from melt – 1 and from solution – 2, a composite with a filler content of 10% – 3, 20% – 4, 35% – 5, 50% – 6.

1. S. Krimm, *Infrared Spectra of High Polymers* (Fortschritte Der Hochpolymeren-Forschung), 51 (1960).
2. R.A. Hoult, B. Perston, R.A. Spragg, *Spectroscopy* **28**, 2 (2013).